Surname	Centre Number	Candidate Number
Other Names		2

GCE A level

1214/01

GEOLOGY - GL4
INTERPRETING THE GEOLOGICAL RECORD

A.M. WEDNESDAY, 8 June 2011

2 hours

			Examiner only
Section A	1.	15	
	2.	15	
	3.	16	
	4.	14	
Section B	5.	10	
	6.	14	
	7.	6	
	8.	10	
Total		100	

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ADDITIONAL MATERIALS

In addition to this examination paper, you will need:
- the Geological Map Extract (Clitheroe and Gisburn);
- a hand-lens or magnifier to study the map (optional);
- a calculator;
- a protractor.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

Candidates are reminded that marking will take into account the quality of communication used in their answers.

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SECTION A

Answer **all** *questions in the spaces provided.*

This section should take approximately 1 hour to complete.

1. **Figures 1a** and **1b** show the variation in percentage of two minerals, augite (pyroxene) and plagioclase feldspar within a dolerite sill. **Figure 1c** shows the crystallisation temperature ranges of common silicate minerals in Bowen's Reaction Series.

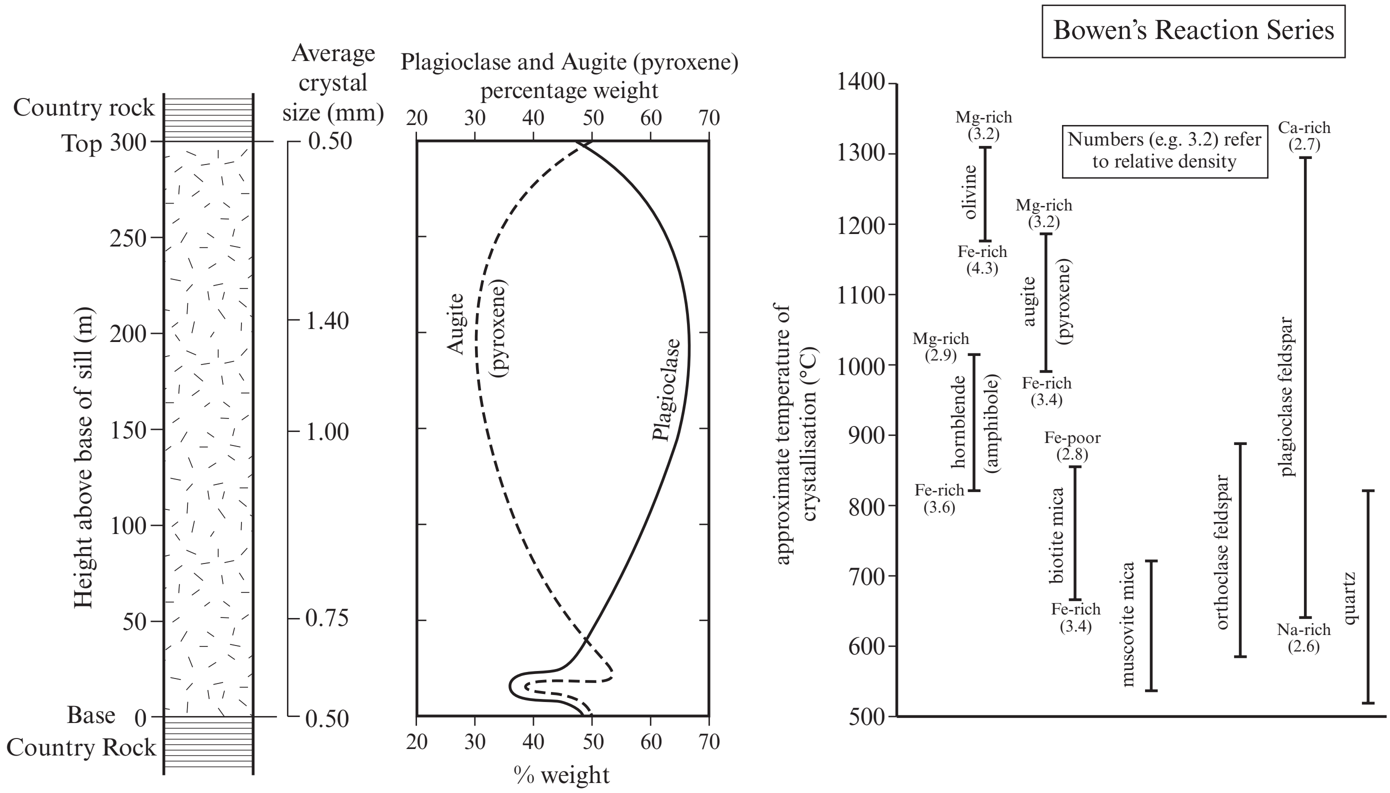

Figure 1a **Figure 1b** **Figure 1c**

Height above base of sill (m)	Augite (pyroxene) (% weight)	Plagioclase Feldspar (% weight)	Dominant Plagioclase composition
Top (300)	•	48	Ca-rich
200	30	67	Na-rich
150	32	•	Na-rich
50	•	52	Ca-rich
Base (zero)	50	48	Ca-rich

Table 1

Examiner only

(a) Describe and account for the variation in average crystal size (**Figure 1a**) within the sill. [3]

Describe ....

....

Account ....

....

....

(b) (i) Complete **Table 1** to show the variation in percentages of augite (pyroxene) and plagioclase at selected heights above the base of the sill. [3]

(ii) With reference to **Figures 1b** and **1c**, explain the change from Ca-rich to Na-rich plagioclase in **Table 1**, between 50 and 200 metres above the base of the sill. [3]

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(c) (i) Olivine is another mineral found within this dolerite sill. Draw a horizontal line (labelled **O**) on **Figure 1b** to show the approximate height of an olivine-rich layer with a composition of 25% olivine. [1]

(ii) On **Figure 1a**, mark with a labelled cross (**+M**) a location where the dolerite has a similar composition to the original magma. Explain your answer. [3]

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(d) Using the data in **Figure 1c**, explain why dolerite is more likely to be prone to **chemical** weathering than granite. [2]

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Total 15 marks

Examiner only

2. Mineral assemblages in metamorphic rock partly depend on the compositon of the parent material and also on the temperature and pressure conditions during metamorphism, as shown in **Figure 2a**.

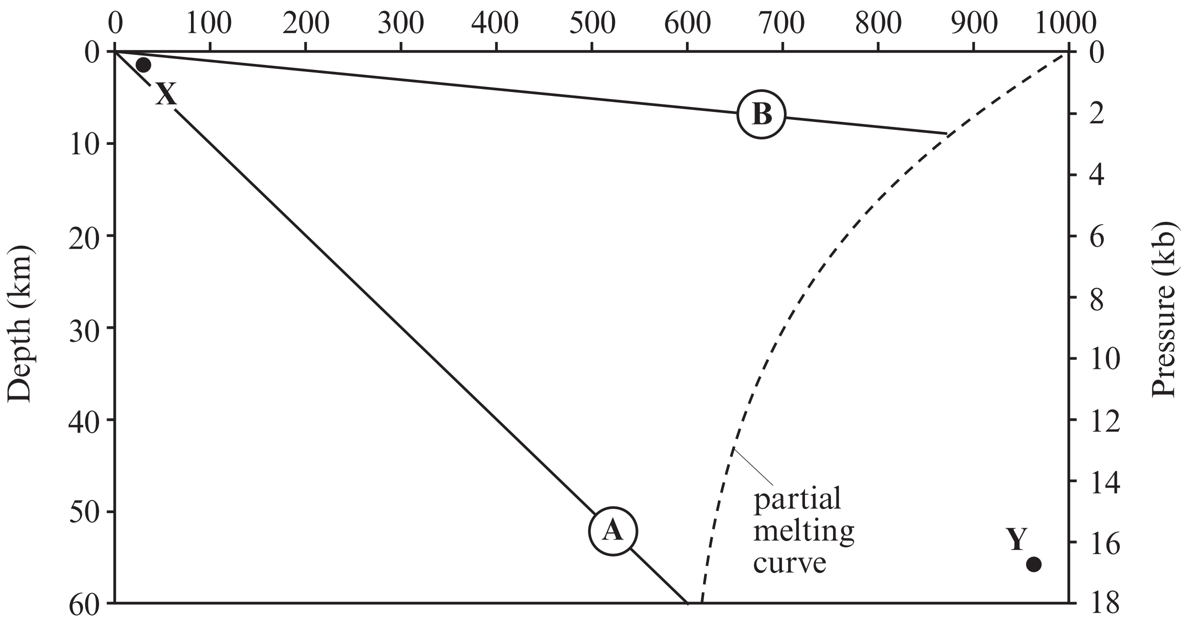

Figure 2a

Refer to **Figure 2a**.

(a) State the **main** geological processes (**igneous**, **sedimentary** or **metamorphic**) operating under the temperature and pressure conditions at locations **X** and **Y**. [2]

X .... **Y** ....

(b) (i) Calculate the geothermal gradient of the line **A**. Show your working. [2]

.... °C km^{-1}

(ii) Draw a line on **Figure 2a** to represent the geothermal gradient of 25 °C km^{-1}. Label it **C**. [1]

(iii) State along which geothermal gradient (**A**, **B** or **C**) the metamorphic rock **hornfels** is most likely to form. Explain your answer. [3]

Geothermal gradient (**A**, **B** or **C**) ☐

Explanation ....

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Examiner only

Figure 2b is a diagram of a metamorphic rock with a porphyroblastic texture.

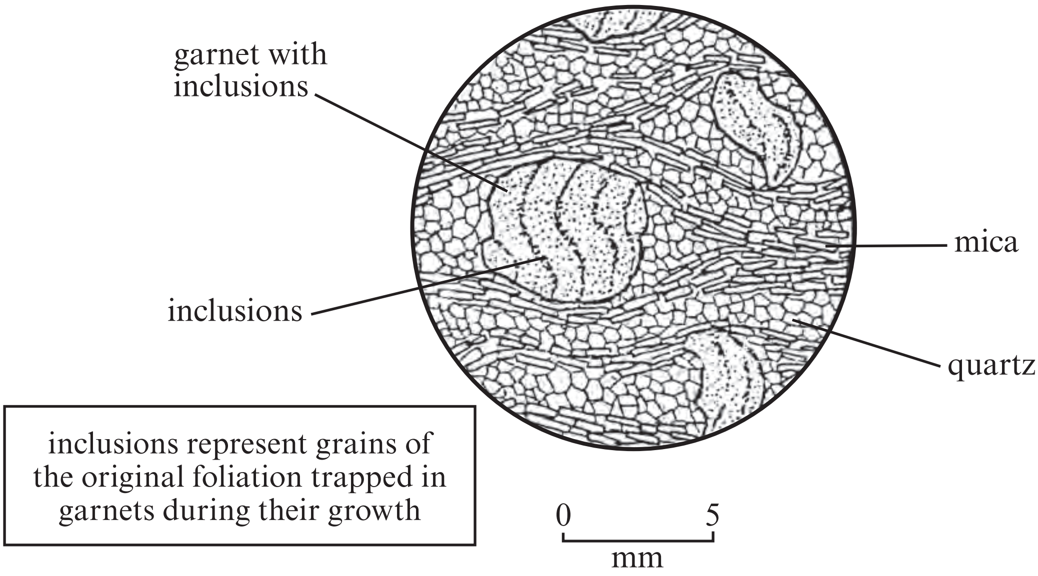

Figure 2b

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(c) (i) On **Figure 2b**, label a porphyroblast with an arrow (← **P**). [1]

(ii) Use **Figure 2b** to explain the meaning of the term *porphyroblastic texture.* [3]

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(d) (i) On **Figure 2b**, draw a line (labelled **F**) to show the most recent foliation direction. [1]

(ii) Outline the evidence from **Figure 2b** to suggest that the principal stress directions have changed during the metamorphism of this rock. [2]

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Total 15 marks

Examiner only

3. **Figure 3a** is a partly completed geological map of an area of near **horizontal** ground.

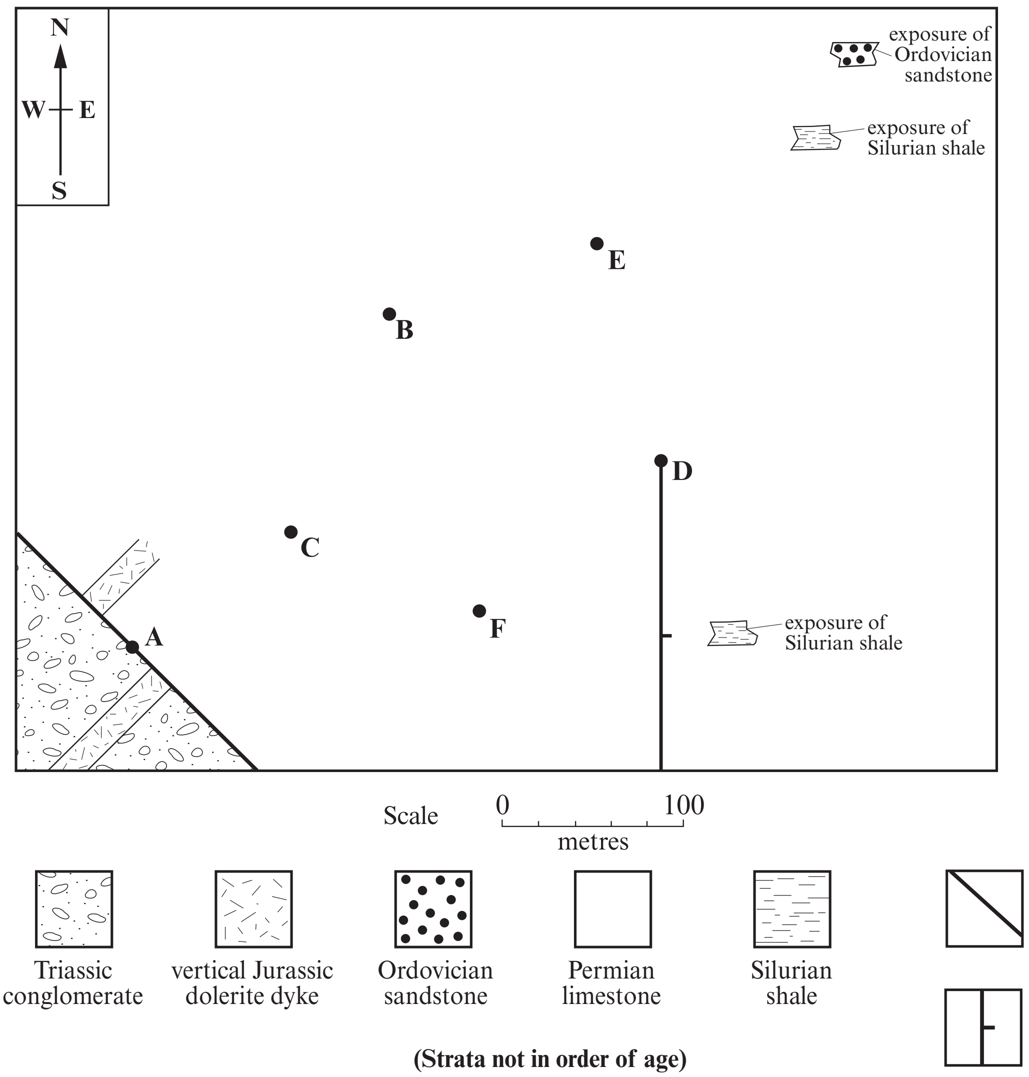

Figure 3a

Exposure A (already completed)	A **Tertiary** fault, with a NW-SE strike. The fault is vertical with **Triassic** conglomerate outcropping to the SW. A NE-SW trending, vertical, dolerite dyke of **Jurassic** age cuts the conglomerate.
Exposure B	The centre of a 20 metre wide dolerite dyke of **Jurassic** age, with a NE-SW trend.
Exposure C	The unconformable base of a **Permian** limestone, with a N-S strike which dips West at 10 degrees.
Exposure D (partially completed)	A **Carboniferous** dip-slip fault, with a N-S strike. The fault dips at 76 degrees to the West, and strata are downthrown to the East.
Exposure E	The conformable boundary between **Ordovician** sandstone and **Silurian** shale, striking E-W and dipping 30 degrees to the **South**.
Exposure F	The conformable boundary between **Ordovician** sandstone and **Silurian** shale, striking E-W and dipping 30 degrees to the **North**.

Table 3

Examiner only

(a) Using information from the six exposures (**A-F**) in **Table 3** and other map evidence, complete the geological map (**Figure 3a**). Use the appropriate shading provided in the key. The data have already been completed on the map for **Exposure A** and partially completed for **Exposure D**. [8]

(b) State the type of fault represented by the Carboniferous dip-slip fault at **Exposure D**. [1]

Fault type ....

(c) **Figure 3b** is a photograph of near vertical structures seen on the fault plane at **Exposure A**.

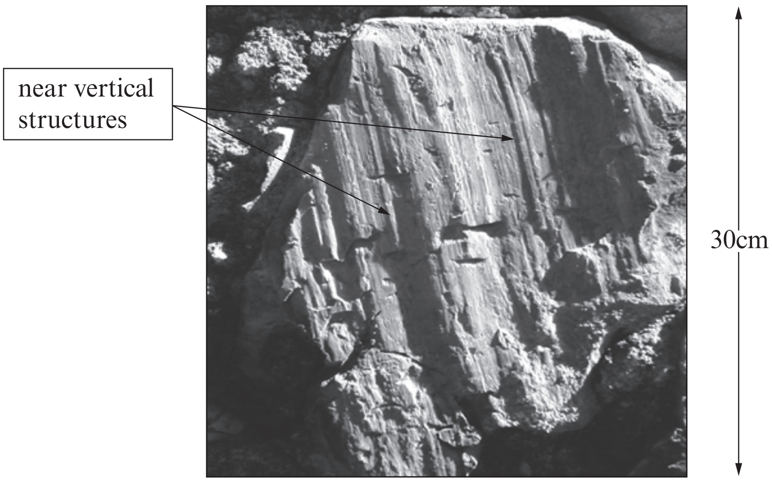

Figure 3b

Name the structures and explain their formation. [2]

Name ....

Formation ....

....

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Turn over.

(d) Using **Figures 3a** and **3b** and **Table 3**, a student concluded that:

1. the dyke formed
   - after the Triassic
   - by tension stresses from the NE/SW

2. the vertical fault (Exposure **A**)
   - has a downthrow side to the SW
   - shows evidence of strike-slip movement
   - has a final direction of movement to the left (sinistral)

Evaluate these statements explaining the **evidence** for your conclusions. [5]

1. ....

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....

....

2. ....

....

....

....

Total 16 marks

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4. **Figure 4a** shows the variation in ^{18}O:^{16}O ratios measured in marine sediments over the last 150,000 years. **Figure 4b** shows changes to atmospheric CO_2, trapped in the Antarctic ice, over the same time period.

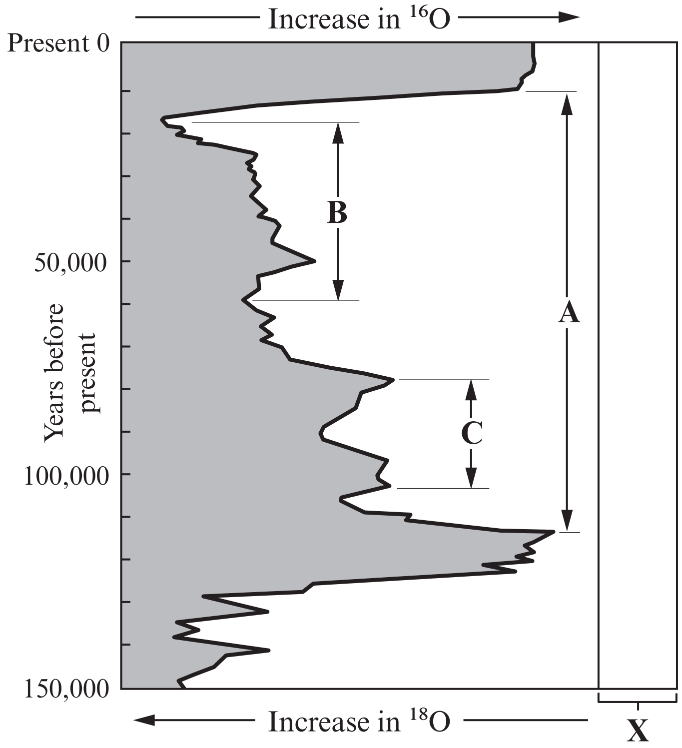

Figure 4a

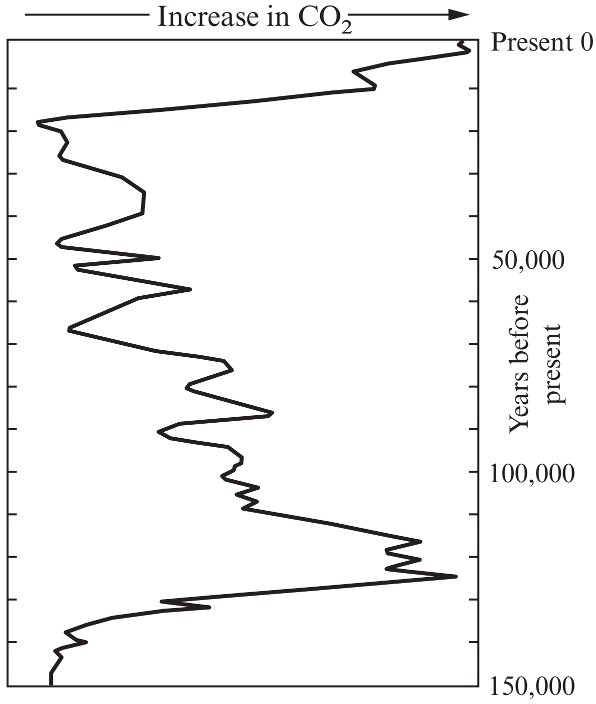

Figure 4b

Source: Earth's Climate, Ruddiman (2008)

(a) **Figure 4a** shows evidence of three cycles (**A**, **B** and **C**) as predicted by Milankovitch. Complete **Table 4** below to identify the approximate length and possible cause of each cycle. [3]

Cycle	Cycle length (years)	Possible cause of Milankovitch cycle
A	•	Eccentricity (variations in the shape of Earth's orbit)
B	~41,000	•
C	•	Procession (variation in the wobble of Earth's axis)

Table 4

Examiner only

(b) The variations in $^{18}O:^{16}O$ ratios are thought to indicate growth and decline of continental ice sheets.

(i) In the box labelled **X** on **Figure 4a**, mark with labelled arrows:

- the peak of **one** glacial period (← **G**)
- the peak of **one** interglacial period (← **I**) [2]

(ii) Explain why the ratio of $^{18}O:^{16}O$ in marine sediments varies during glacial and interglacial periods. [3]

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....

(c) From your knowledge, state **one natural** process that has been a major contributor in:

1. adding CO_2 to the atmosphere throughout geological time;
2. removing CO_2 from the atmosphere throughout geological time. [2]

1. ....

2. ....

(d) Refer to **Figures 4a** and **4b**.

(i) Describe the correlation between the ratio of $^{18}O:^{16}O$ in marine sediments and atmospheric CO_2 during the last 150,000 years. [2]

....

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(ii) *"Glacial and interglacial periods are a direct result of changes in the concentration of CO_2 in the atmosphere during geological time."*

Critically evaluate this statement. [2]

....

....

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Total 14 marks

Examiner only

SECTION B

Questions **5-8** *relate to the* **British Geological Survey 1:25 000 geological map** *extract from the* **Clitheroe and Gisburn** *Sheet.*

Answer **all** *questions in the spaces provided.*

This section should take approximately 1 hour to complete.

5. *(a)* (i) State the type of superficial (drift) deposit overlying the Pendle Grit (**PG**) on Pendle Hill (**grid square 7941**). [1]

....

(ii) Account for the irregular outcrop pattern of this deposit in **grid square 7940**. [1]

....

(b) (i) Using the **generalised geological column**, calculate the maximum vertical thickness of the Pendleside Sandstone unit (**PdS**) within the Lower Bowland Shales (**LBS**). Show your working. [2]

Maximum vertical thickness .... m

(ii) Complete **Table 5** below by calculating the width of outcrop of the Pendleside Sandstone (**PdS**) along the line of section (**X–Y**) on the **geological map** (between **grid reference** (**GR**) **812431** and **GR 827419**). Show your working. [2]

Pendleside Sandstone (**PdS**)	
Maximum width of outcrop (m) within **grid square 7841**	Width of outcrop (m) between **GR 812431** and **GR 827419**
310	*Working* *Answer* .... m

Table 5

Examiner only

(iii) Suggest **two** possible factors responsible for the variation in outcrop widths identified in **Table 5**. [2]

Factor 1 ....

....

Factor 2 ....

....

(iv) Account for the "v shape" in the outcrop pattern of the Pendleside Sandstone (**PdS**) around **GR 810 430**. [2]

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Total 10 marks

Examiner only

6. **Table 6** and **Figure 6a** show the results of an investigation of three different rock samples from the map area.

Sample characteristics	Pendleside Sandstone (**PdS**) (within **LBS**)	Upper Bowland Shale (**UBS**)	Pendle Grit (**PG**)
Fossils groups	trilobites	goniatites, bivalves	poor – some plant remains
Sedimentary structures	bedding	laminations	channels, erosion surfaces, flute and groove casts; some lateral and vertical grading of sediments
Sand percentage	60	0	•
Silt percentage	25	5	•
Clay percentage	15	95	10

Table 6

Grain size

Sand $(2 - \frac{1}{16})$ mm

Silt $(\frac{1}{16} - \frac{1}{256})$ mm

Clay $< \frac{1}{256})$ mm

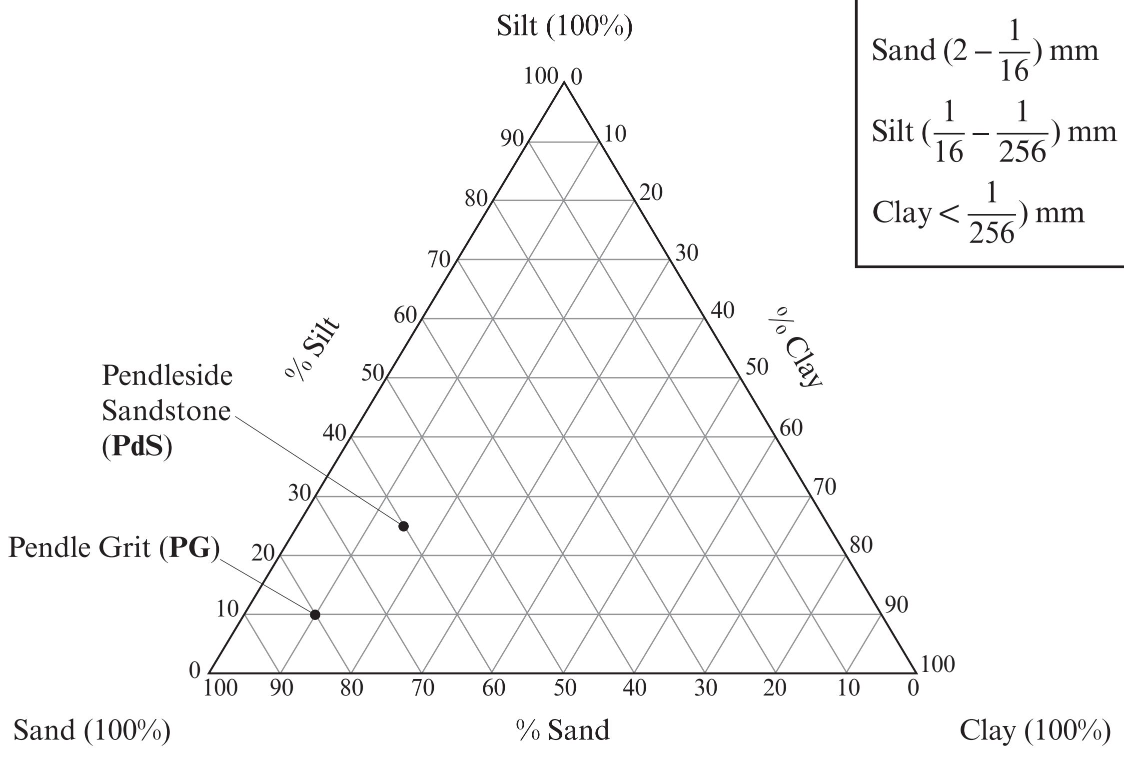

Figure 6a

Examiner only

(a) Using **Table 6** and **Figure 6a** as appropriate:

(i) complete **Table 6** to show the percentage of sand, silt and clay in the Pendle Grit (**PG**); [2]

(ii) plot the percentage of sand, silt and clay in the Upper Bowland Shale (**UBS**) on **Figure 6a**. Label with an arrow (←**UBS**); [1]

(iii) state which of the three rock samples (Pendle Grit, Pendleside Sandstone or Upper Bowland Shale) is the **most** poorly-sorted. [1]

....

(b) Refer to the **generalised geological column** and data in **Table 6** and **Figure 6a**. Describe and explain the evidence for the environments of deposition of the Upper Bowland Shale (**UBS**) and the overlying Pendle Grit (**PG**). [4]

Upper Bowland Shale ....

....

....

Pendle Grit ....

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....

(c) Explain why a spring has formed at Deep Clough (**GR 805 405**). [2]

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Examiner only

(d) **Figure 6b** illustrates one of the fossil groups identified in **Table 6**.

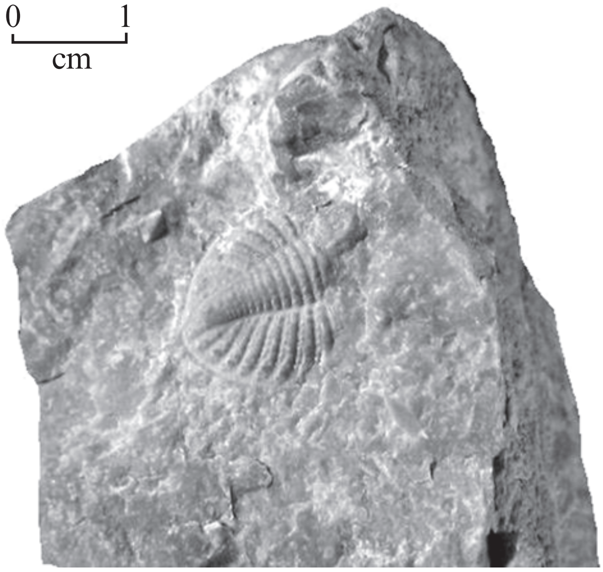

Figure 6b

(i) State the fossil group to which this specimen belongs. [1]

Fossil group ....

(ii) Assess **how useful** this fossil **alone** would be in determining the
- mode of life of the original organism and
- the environment of deposition of the rock in which it is found. [3]

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Total 14 marks

Examiner only

7. **Figure 7** is a copy of part of the **geological map**. From the outcrop and dips a student identified **two** plunging folds on the **geological map**.

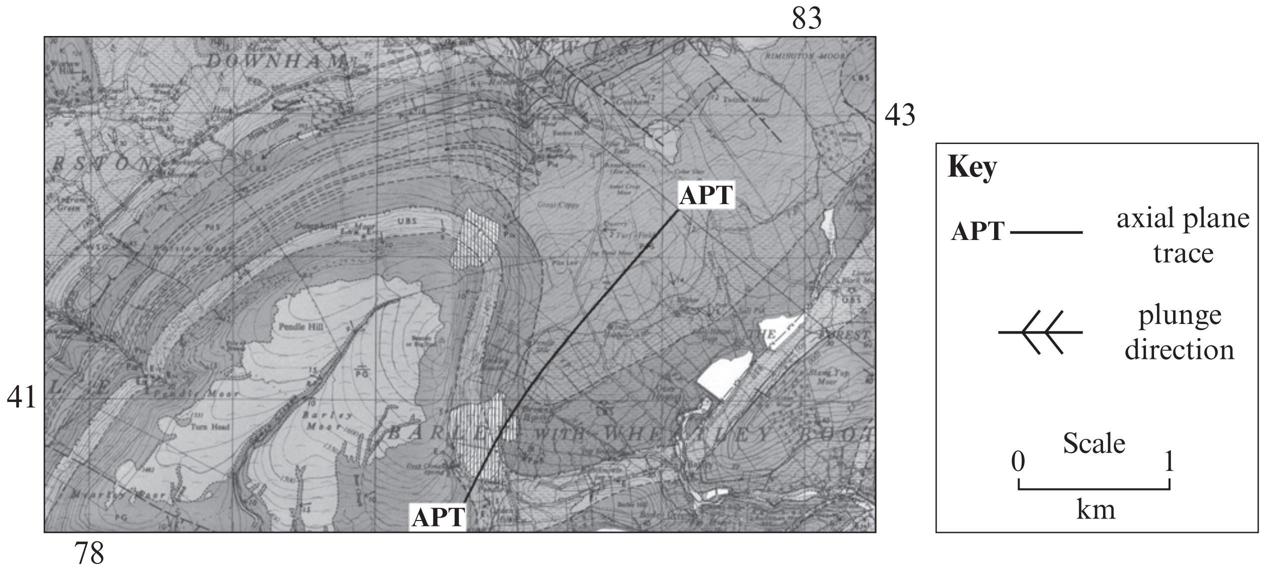

Figure 7

The axial plane trace of one plunging fold is marked on **Figure 7**.

(a) For this marked fold, name the type of fold and state the direction of plunge. [2]

type of fold	•
direction of plunge	•

(b) On **Figure 7**, draw the axial plane trace of another plunging fold. Use the symbols in the key to indicate the direction of plunge of this fold. [2]

(c) The student described these plunging folds as having

"...a wavelength of approximately 1 km...".

Critically evaluate this statement. [2]

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Total 6 marks

Turn over.

Examiner only

8. *(a)* Suggest a probable geological explanation for the choice of location of the two reservoirs (shaded white) in **grid square 8241**. [3]

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(b) Two landslips have developed on Pendle Hill. With reference to evidence from the **geological map**, evaluate the likelihood that the following factors were responsible for the landslides at these locations.

- Rock type
- Dip (angle and direction) of beds
- Steepness of the slope
- Local groundwater conditions
- Faulting [7]

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Total 10 marks

WJEC
CBAC

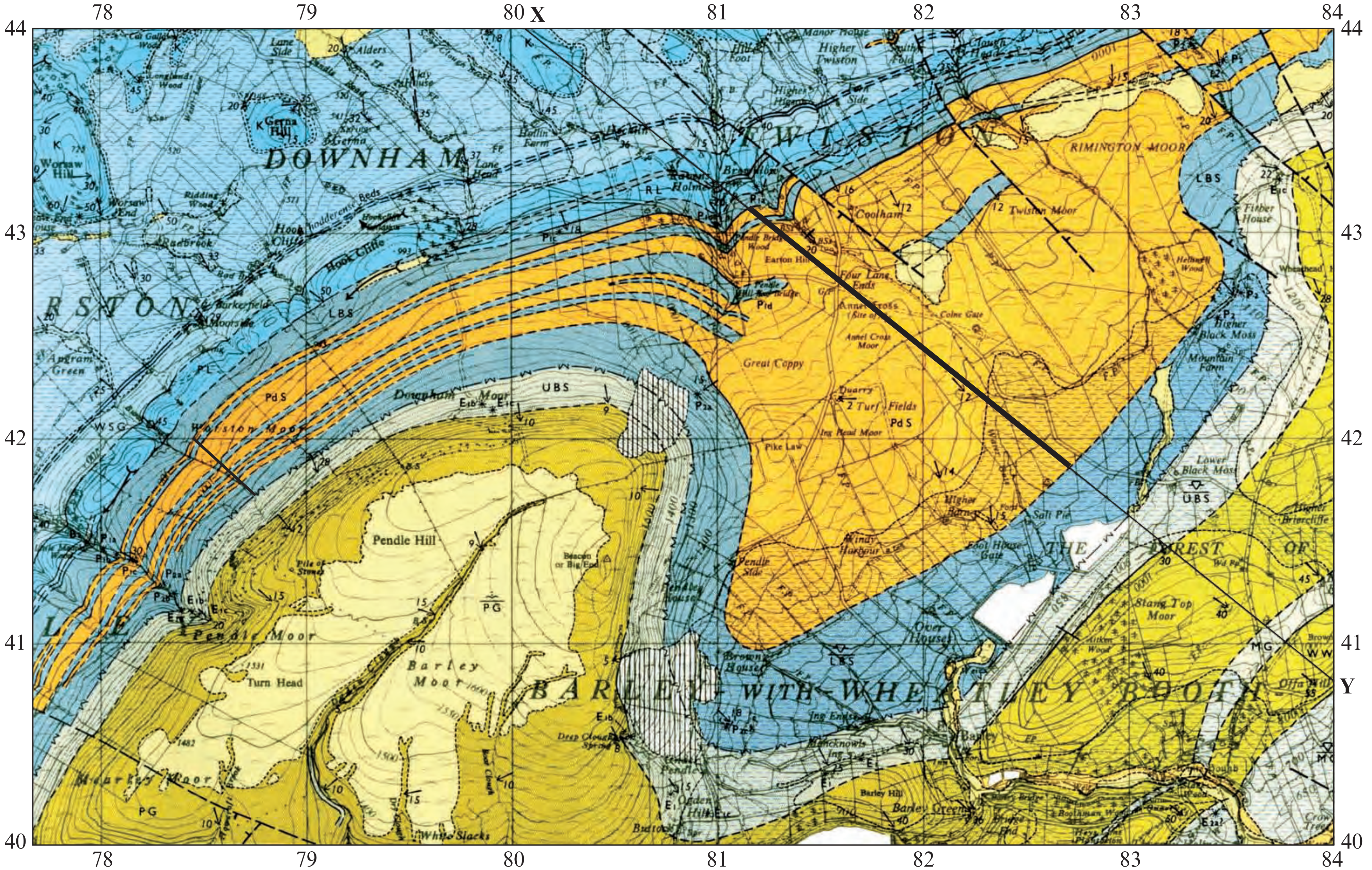
GCE A level

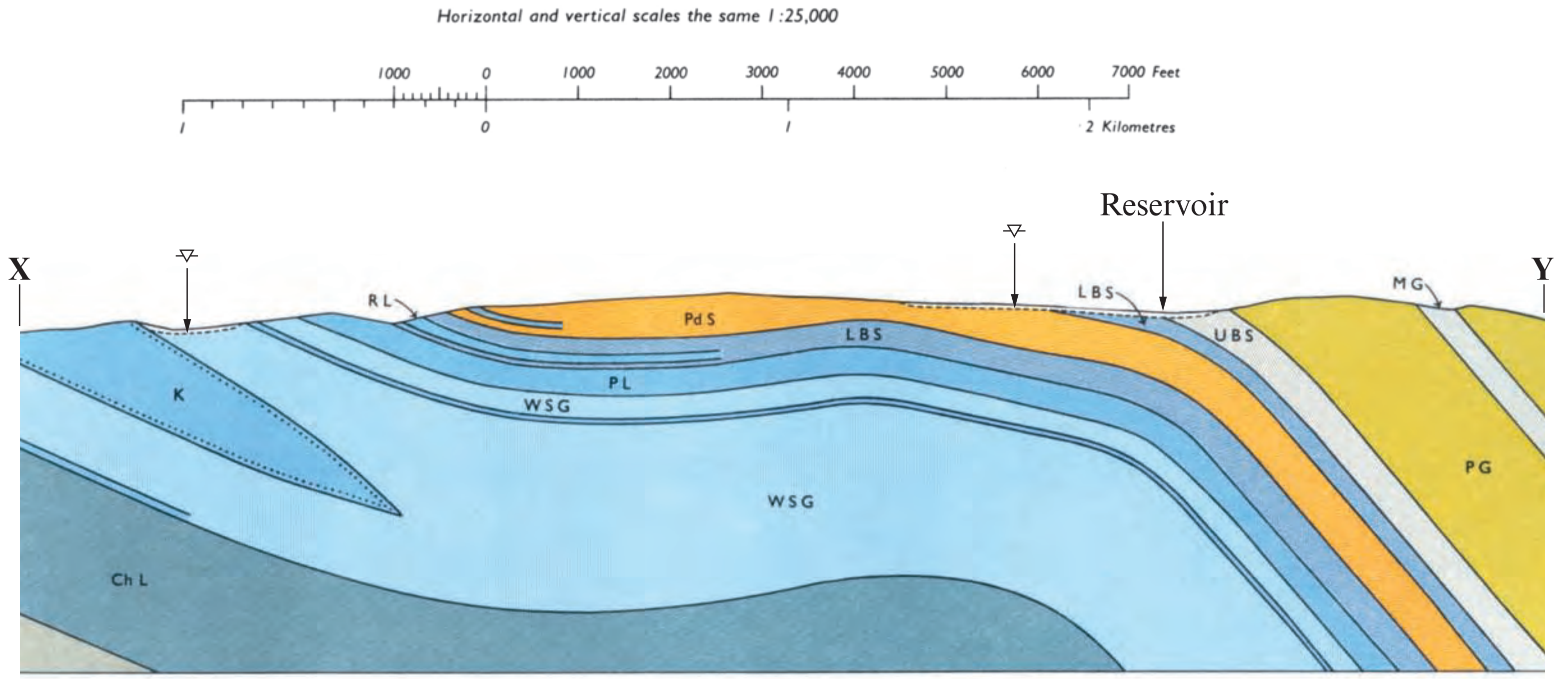
1214/01-A

GEOLOGY - GL4
Geological Map Extract

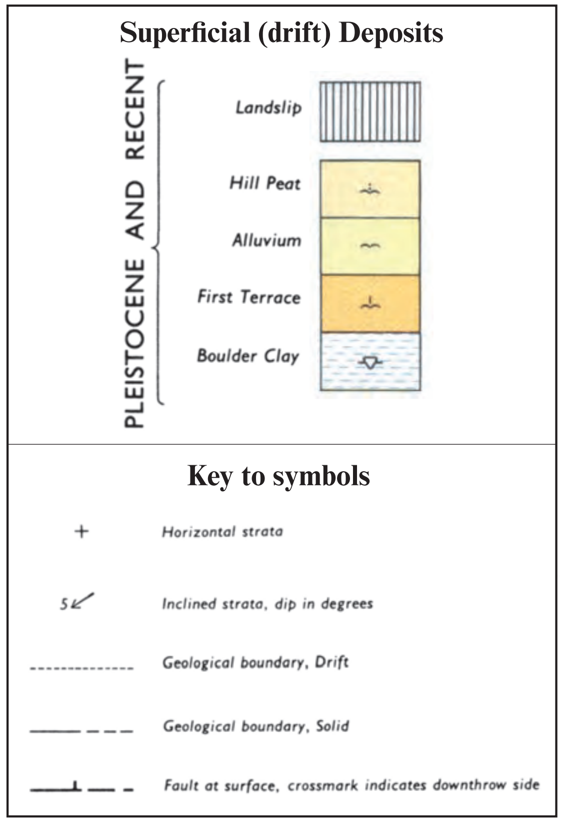
A.M. WEDNESDAY, 8 June 2011

WJEC 1214/01-A ADVANCED GEOLOGY GL4 JUNE 2011
Extract from Clitheroe and Gisburn (Solid and Drift) 1:25 000 (1cm to 250m)





CROSS-SECTION SHOWING THE GENERAL RELATIONS OF ROCKS ALONG THE LINE **X–Y**



GENERALISED GEOLOGICAL COLUMN
Scale 1:9 000 (1cm to 90m)
Solid Geology